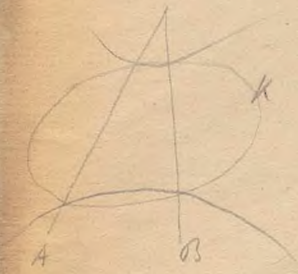
Dr. Emil Weyr IV. 5. 92.

Analytische Geometrie.

M Smoluchowski

[illegible] $a_{11}x^2$

4 [illegible]



$A=0$ $B=0$

$AB=0$: [illegible]

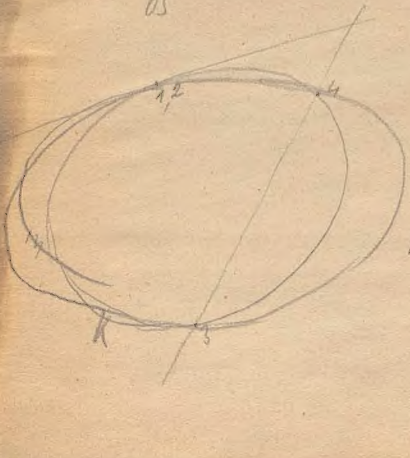
$K=0$

$K+\lambda AB=0$ [illegible]

[illegible] $K\,AB$ [illegible]

[illegible]

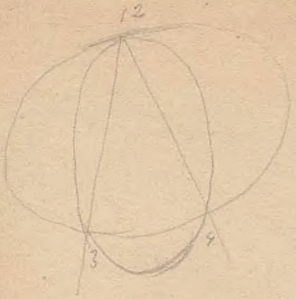
$AB+\lambda CD=0$

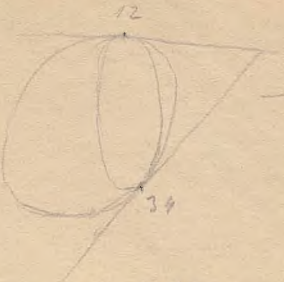


[illegible] 2 [illegible]

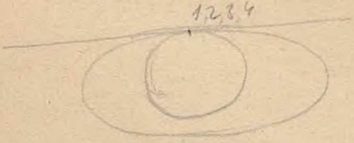
[illegible]; 3 — oscul.

$K+\lambda AB=0$





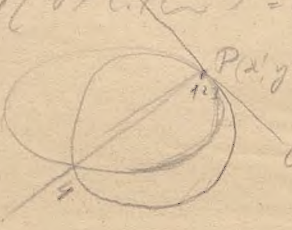
$K+\lambda A^2=0$



Oscul. [illegible] 2 [illegible] 3. [illegible]

[illegible] 3 [illegible] ([illegible] C. X [illegible]) = Oscul. [illegible]

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}-1=0$$



[illegible]

(P [illegible] Oscul. [illegible]

$K+\lambda AB=0$ $\qquad B = \cancel{m}(x-x')+n(y-y')=0$

$$\frac{xx'}{a^2}+\frac{yy'}{b^2}=-1$$

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}-1+\lambda\left(\frac{xx'}{a^2}+\frac{yy'}{b^2}-1\right)\left[m(x-x')+n(y-y')\right]=0$$

[illegible] : [illegible] —— Coeff. [illegible] x^2 = C. [illegible] y^2 [illegible]

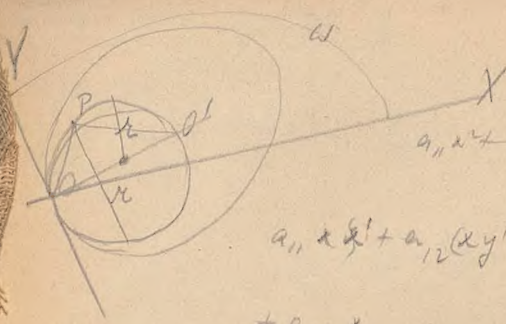
[illegible] P [illegible] 4 [illegible]

$K+\lambda K^2=0$

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}-1+\lambda\left[\frac{xx'}{a^2}+\frac{yy'}{b^2}-1\right]^2=0$$

M. Parabel $a_{11}\,a_{22}-a_{12}^{2}=0$

[illegible]



$a_{11}x^2+$ ——

~~$a_{13}=0$~~

[illegible]

$$a_{11}xx'+a_{12}(xy'+x'y)+a_{22}yy'+$$

$$+a_{13}x \quad —— \quad =0$$

$$a_{13}x+a_{23}y=0 \quad \Big| \quad t_1 \qquad a_{23}=0$$

$$y=0$$

$$a_{11}x^2+2a_{12}xy+a_{22}y^2+2a_{13}x=0$$

$OM=x$ $\qquad OP^2=OM'.OO'$

$MP=y$ $\qquad =x^2+2xy\cos\omega+y^2$

$$OM'=OM\sin\omega=x\sin\omega$$

$$\cancel{OP^2}=x^2+2xy\cos\omega+y^2-2r\sin\omega.x=0$$

$$\left.\begin{array}{l} a_{11}x^2+2a_{12}xy+a_{22}y^2+2a_{13}x=0 \\ x^2+2xy\cos\omega+y^2-2r\sin\omega.x=0 \end{array}\right\} \Bigg| -a_{22}$$

$$(a_{11}-a_{22})x^2+2(a_{12}-a_{22}\cos\omega)xy+2(a_{13}+ra_{22}\sin\omega)x=0$$

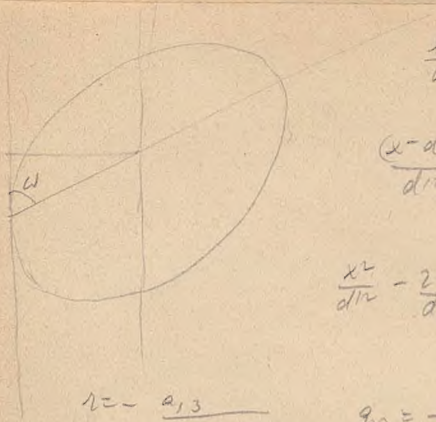
$$x\left[(a_{11}-a_{22})x+2(a_{12}-a_{22}\cos\omega)y+2(a_{13}+ra_{22}\sin\omega)\right]=0$$

2 [illegible] $\begin{cases} x=0 \text{ ------ } Y_{00} \\ (a_{11}-a_{22})x+2(a_{12}-a_{22}\cos\omega)y+2(a_{13}+ra_{22}\sin\omega)=0 \end{cases}$

[illegible] (34)

[illegible] 0 [illegible] Osc. [illegible]

$$a_{13}+ra_{22}\sin\omega=0 \quad \Big| \quad \text{Rad. [illegible]}: r=-\frac{a_{13}}{a_{22}\sin\omega}$$



$$\frac{x'^2}{d'^2} + \frac{y'^2}{d''^2} - 1 = 0$$

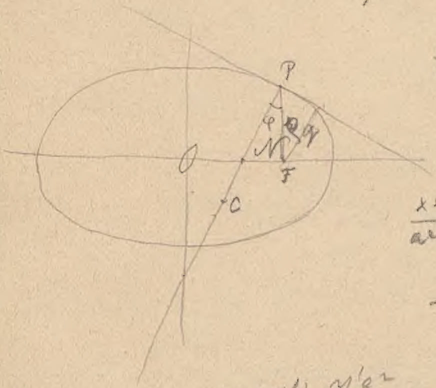
$$\frac{(x-d')^2}{d'^2} + \frac{(y~~\ldots~~)^2}{d''^2} - 1 = 0$$

$$\frac{x^2}{d'^2} - \frac{2x}{d'} + \frac{y^2}{d''^2} = 0$$

$$r = -\frac{a_{13}}{a_{22}\sin\omega} \qquad a_{13} = -\frac{1}{d'}$$

$$r = \frac{1}{d'\frac{\sin\omega}{d''^2}} = \frac{d''^2}{d'\sin\omega}$$

$$p = d'\sin\omega \qquad r = \frac{d''^2}{p}$$



$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$C = x_y \vartheta_\ell$$

$$\frac{xx'}{a^2} + \frac{yy'}{b^2} = 1$$

$$-\frac{x'b^2}{y'a^2} \qquad \frac{y'a^2}{x'b^2}$$ senkrecht.

$$y - y' = \frac{y'a^2}{x'b^2}(x - x') \quad \Big| \quad y = 0$$

$$x = -\frac{x'b^2}{a^2} + x' = ON = x'\frac{a^2 - b^2}{a^2}$$

$$PN^2 = \left[x' - x'\frac{a^2 - b^2}{a^2}\right]^2 + y'^2 = x'^2\frac{b^4}{a^4} + y'^2 = \frac{b^2}{a^2}\left[\frac{b^2x'^2}{a^2} + \frac{a^2y'^2}{b^2}\right]$$

$$= d''^2$$

$$PN = \frac{bd''}{a}$$

$\rho = a - ex'$ $\quad \cos\varphi = \frac{q}{\rho}$

$$-\frac{\frac{xx'}{a^2} + \frac{yy'}{b^2} - 1}{\sqrt{\frac{x'^2}{a^4} + \frac{y'^2}{b^4}}} \Bigg| \begin{matrix} x = c \\ y = 0 \end{matrix} = q \qquad q = 1 - \frac{cx'}{a^2}$$

$$q = \frac{ab\left(1 - \frac{ex'}{a}\right)}{d''} = \frac{b(a - ex')}{d''} = \frac{b\rho}{d''}$$

$$\cos\varphi = \frac{b}{d''}$$

$$p = \frac{1}{\sqrt{\frac{x'^2}{a^4} + \frac{y'^2}{b^4}}} = \frac{ab}{\sqrt{\frac{b^2x'^2}{a^2} + \frac{a^2y'^2}{b^2}}} = \frac{ab}{d''}$$

$$r = \frac{d''^2}{\frac{ab}{d''}} = \frac{d''^3}{ab} = \cancel{d''^2}\ \frac{PN}{\cos^2\varphi}$$

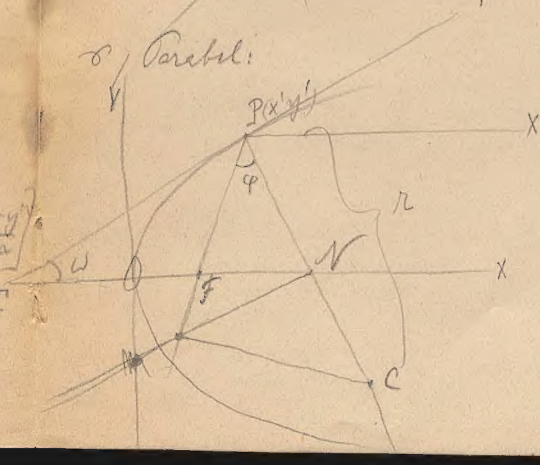
Constr.

$NQ \perp NP$

$QC \perp QP$

~~QP~~

c) Parabel:



$y^2 = 2p'x$

$y^2 - 2p'x = 0 \qquad p' = \frac{p}{\sin^2\omega}$

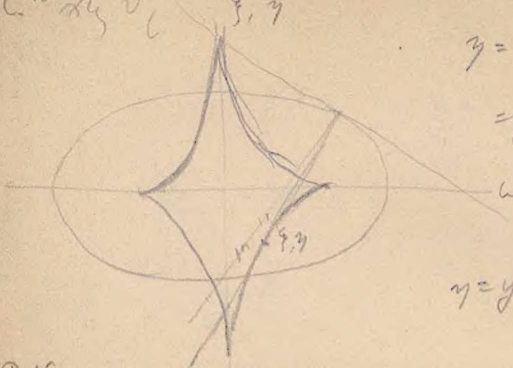
$r = -\frac{a_{13}}{a_{22}}\sin\omega$

$a_{22} = 1 \qquad a_{13} = -p'$

$r = \frac{p'}{\sin\omega} = \frac{p}{\sin^3\omega}$

$TN = p'$ $\quad = \frac{PN}{\cos^2\varphi}$

C. ⁰ [illegible]



$\eta = y' - PC\cos\varphi$

$= y' - r\cos\varphi$

$\cos\varphi = \frac{y'}{PN}$

$\eta = y' - \frac{d''^2}{p}\frac{y'}{PN}$

PN —— $\frac{bd''}{a}$

$\eta = y'\left[1 - \frac{d''^2}{p}\frac{a}{bd''}\right]$

$= y'\left[1 - \frac{ad''}{pb}\right] = y'\left[1 - \frac{ad''^2}{ab^2}\right]$

$d''^2 = \frac{b^2y'^2}{a^2}$

$= y'\frac{b^2 - d''^2}{b^2} = y'\frac{b^2 - \left(\frac{b^2x'^2}{a^2} - \frac{a^2y'^2}{b^2}\right)}{b^2}$

$= y'\left[\quad\right] = y'^3\frac{(b^2 - a^2)}{b^4}$

Evolute in dim.

$x' = \sqrt[3]{\frac{a^4\xi}{c^2}} \qquad y' = -\sqrt[3]{\frac{b^4\eta}{c^2}}$

$\frac{1}{a^2}\sqrt[3]{\frac{a^8\xi^2}{c^4}} + \frac{1}{b^2}\sqrt[3]{\frac{b^8\eta^2}{c^4}} = 1$

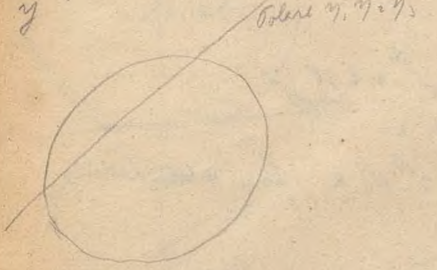
$\sqrt[3]{\frac{a^2\xi^2}{c^4}} + \sqrt[3]{\frac{b^2\eta^2}{c^4}} = 1$

$a^{\frac{2}{3}}\xi^{\frac{2}{3}} + b^{\frac{2}{3}}\eta^{\frac{2}{3}} = c^{\frac{4}{3}}$

4/5

$$a_{11} x_1^2 + a_{22} x_2^2 + a_{33} x_3^2 + 2a_{12} x_1 x_2 + 2a_{13} x_1 x_3 + 2a_{23} x_2 x_3 = 0$$

y



$$y_1(a_{11} x_1 + a_{12} x_2 + a_{13} x_3) +$$
$$+ y_2(a_{21} x_1 + a_{22} x_2 + a_{23} x_3) +$$
$$+ y_3(a_{31} x_1 + a_{32} x_2 + a_{33} x_3) = 0$$

$$a_{ik} = a_{ki}$$

[illegible]

$$x_1(a_{11} y_1 + a_{12} y_2 + a_{13} y_3) + x_2(a_{21} y_1 + a_{22} y_2 + a_{23} \quad) -)$$

$$+ x_3 (\qquad\qquad) = 0$$

C e C, C. ° C.

$$\rho . \eta_1 = a_{11} y_1 + a_{12} y_2 + a_{13} y_3$$
$$\rho \eta_2 = a_{21} y_1 + a_{22} y_2 + a_{23} y_3$$
$$\rho \eta_3 = a_{31} y_1 + a_{32} y_2 + a_{33} y_3$$

} [illegible] C.° C. [illegible]

6/ Ty.

$$y_1 \eta_1 + y_2 \eta_2 + y_3 \eta_3 = 0$$

[illegible] ~ C e C.

$$\begin{vmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{vmatrix} = \text{Discrim.}$$

$$\sigma y_1 = A_{11} \eta_1 + A_{21} \eta_2 + A_{31} \eta_3$$
$$\sigma y_2 = A_{12} \eta_1 + A_{12} \eta_2 + A_{32} \eta_3$$
$$\sigma y_3 = A_{13} \eta_1 + A_{23} \eta_2 + A_{33} \eta_3$$

η_1 C. ° C. [illegible] C. e C.
η_2
η_3

η [illegible] C. [illegible] C.

$$0 = A_{11}\eta_1^2 + A_{22}\eta_2^2 + A_{33}\eta_3^2 + 2A_{12}\eta_1\eta_2 + \text{---}$$

= [illegible] C. [illegible] C_0.

[illegible] Discr. = [illegible] $^{\infty}$ [illegible] 2 [illegible]

[illegible]

$$y_1\,(a_{11}m_1 + a_{12}m_2 + a_{13}m_3)$$
$$+\,y_2\,(\qquad\qquad\qquad\qquad)$$
$$+\,y_3\,(\qquad\qquad\qquad\qquad) = 0$$ [illegible] y

[illegible] Coeff. = 0 [illegible]

$$\left.\begin{array}{l} a_{11}m_1 + a_{12}m_2 + a_{13}m_3 = 0 \\ a_{21} \\ a_{31}m_1 + \text{---}\quad a_{33}m_3 = 0 \end{array}\right\}$$ [illegible] Δ [illegible]

[illegible] C. [illegible]

[illegible] $\delta = 0$ [illegible] 2 [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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$x =$ [illegible]

[illegible]

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[illegible] $\pm$ [illegible]

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[illegible] $\pm$ [illegible] $\pm$ [illegible] $\pm$ [illegible]

[illegible]

[illegible] $=$ [illegible]

$=$ [illegible]

$x = \pm$ [illegible]

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1 2

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$x =$ [illegible]

[illegible]

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[illegible]

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T [illegible]

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[illegible]

[illegible]

$V' = V \ldots$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$\frac{(PT_1)^2}{(PT_2)^2} = \lambda \qquad \frac{PT_1}{PT_2} = \sqrt{\lambda}$$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] ± [illegible]

[illegible] − [illegible]

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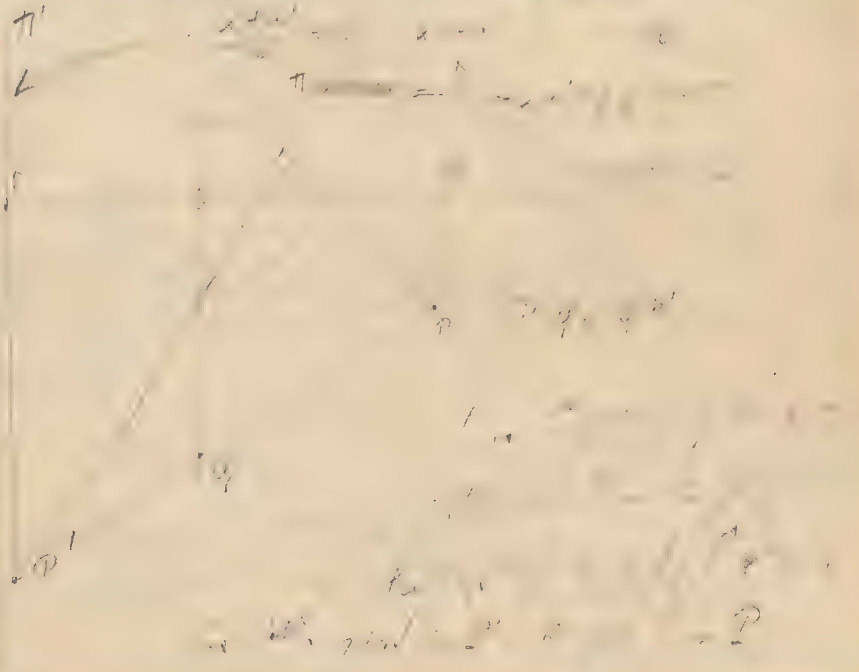
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[illegible]

[illegible]

[illegible] $x =$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

$$\begin{vmatrix} x^2+y^2 & x & y & 1 \\ [illegible] & [illegible] & [illegible] & 1 \\ [illegible] & [illegible] & [illegible] & 1 \\ [illegible] & [illegible] & [illegible] & 1 \end{vmatrix} = 0$$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$\ldots = t$

$a_i^2 + \ldots_i^2 = c_i$ [illegible]

$t + c_1 = 2a\ldots + 2b\ldots + 2\ldots$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] $+ +$ [illegible]

[illegible] $+ -$

[illegible]

[illegible]

[illegible] $= 0$

[illegible] $2)^2 +$ [illegible]

[illegible]

[illegible]

[illegible]

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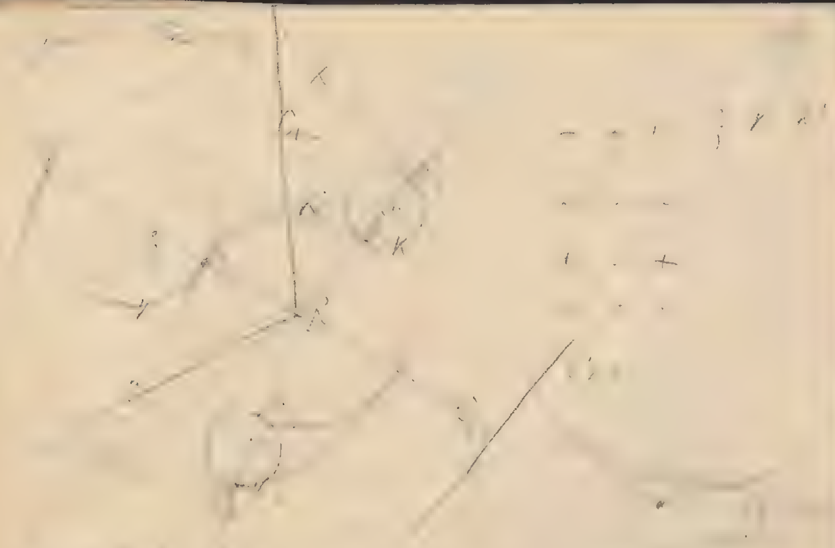

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ [illegible]

$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ [illegible]

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=-1$ [illegible]

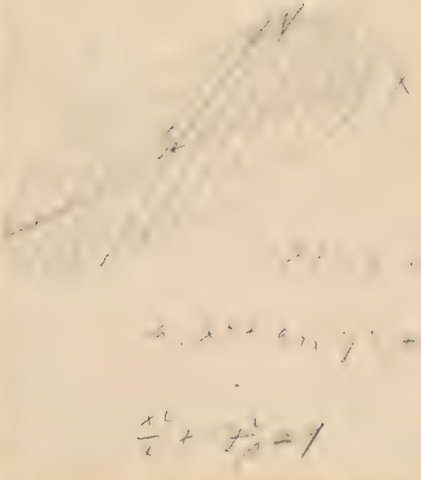
$x^2-\frac{y^2}{b^2}=1$

$-\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=0$ [illegible]

$\frac{x^2}{a^2}-\frac{y^2}{b^2}=0$ [illegible]

[illegible]



$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

$a_{11}x^2+2a_{12}xy+a_{22}y^2+\dots=0$

[illegible]

$a_{11}x^2+a_{22}y^2+a_{33}=0$ $\qquad -\frac{a_{33}}{a_{11}}=a \qquad -\frac{a_{33}}{a_{22}}=b$

$\frac{x^2}{a}+\frac{y^2}{b}=1$

[illegible]

[illegible]

[illegible]

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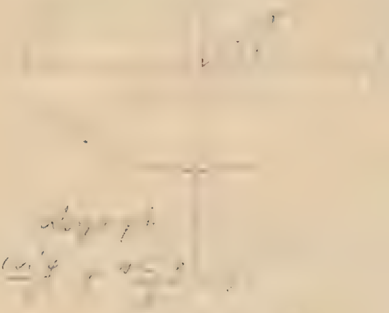

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

~~[illegible]~~

$OP : OP' = [illegible]$

$OP : OP' = [illegible]$

$OP = [illegible]$

$OP = [illegible]$

$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$

$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ [illegible]

[illegible]

[illegible]

$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$\underbrace{\frac{x^2}{a^2}=\frac{y^2}{b^2}}$$

$y=\mp\frac{b}{a}x$ [illegible]

$$\underbrace{\frac{y}{x}=\mp\frac{b}{a}}$$

[illegible]

[illegible] = [illegible] =

= [illegible]

= [illegible]

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[illegible] = [illegible]

[illegible] = [illegible]

[illegible] = [illegible]

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[illegible]

$l^2 =$ [illegible]

$=$ [illegible]

$=$ [illegible]

$d^2 = a^2 - a^2$ [illegible]

$l^2 + d^2 =$ [illegible]

[illegible]

$l^2 -$ [illegible]

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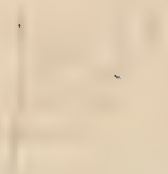

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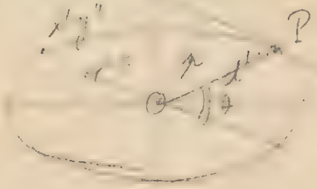
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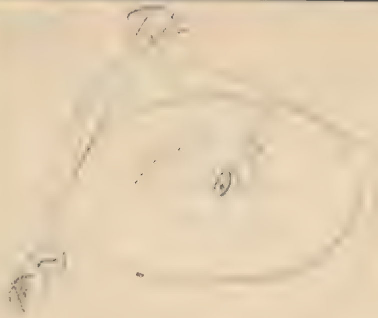

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[illegible]

[illegible]

[illegible]

$OA = \sqrt{\ldots}$ [illegible]

[illegible] $OA' = \sqrt{a^2 - \ldots}$ [illegible] $a > b$

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

$a_{11}x^2 + 2a_{12}xy + a_{22}y^2 = 0$

$\frac{y}{x} = -a_{12} \pm \sqrt{a_{12}^2 - a_{11}a_{22}}$

a_{22}

$$\tan\omega = \pm\frac{\frac{2\sqrt{a_{12}^2 - a_{11}a_{22}}}{a_{22}}}{1 + \frac{a_{11}}{a_{22}}} = \frac{\pm 2\sqrt{a_{12}^2 - a_{11}a_{22}}}{a_{11} + a_{22}}$$

$S \equiv \frac{x^2}{a^2} + \frac{y^2}{b^2} - 1$ [illegible]

$a_{11} = -\frac{1}{a^2}\left(\frac{y'^2}{b^2} - 1\right)$

$a_{22} = -\frac{1}{b^2}\left(\frac{x'^2}{a^2} - 1\right)$

$a_{12} = \frac{x'y'}{a^2b^2}$

[illegible]

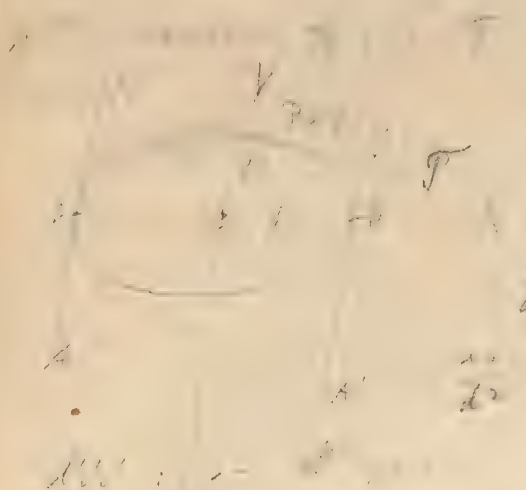
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


V
T

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


M
d'
d
X
N

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] [illegible]

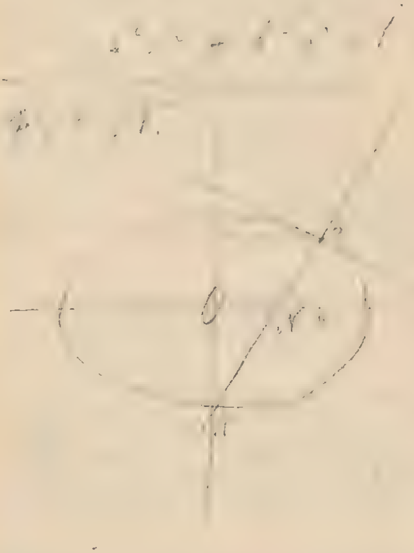
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


O

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] C

[illegible]

[illegible]

[illegible]

[illegible]

$F'F\ NT$ [illegible]

$\angle NPF$ [illegible]

$\overline{PF}\ \overline{FN}$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$r' = (a + ex$ [illegible]

$r + r' = 2a$ [illegible]

[illegible]

$r = ex' - a$

$r' = ex' + a$

$r' - r = 2a$

[illegible] [illegible]

[illegible] [illegible]

[illegible]

[illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] $\sqrt{\ }$ [illegible]

$4x =$ [illegible] $- c\sqrt{-1}$ …

[illegible]

[illegible]

[illegible]

[illegible]

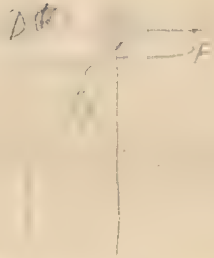
[illegible]

[illegible]

D

[illegible]

[illegible]



[illegible]

$(x-2p)^2+y^2=x^2$

[illegible]

$DC = OF = p$ $y = $ [illegible]

$x = x + p$

$y^2 = 4p(x+p) -$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$[illegible] = 1$$

$$= [illegible] = [illegible]$$

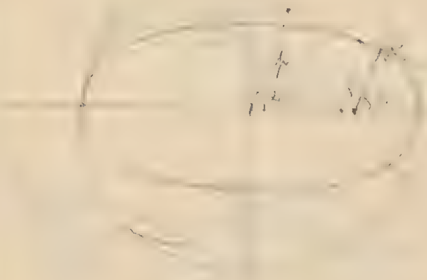
$$= [illegible]$$

[illegible]

[illegible]

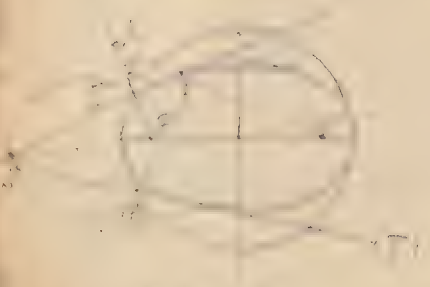
$$\frac{\sin TMP}{\sin T'MP'} = \frac{\sin T'MP}{\sin TMP'}$$

[illegible]

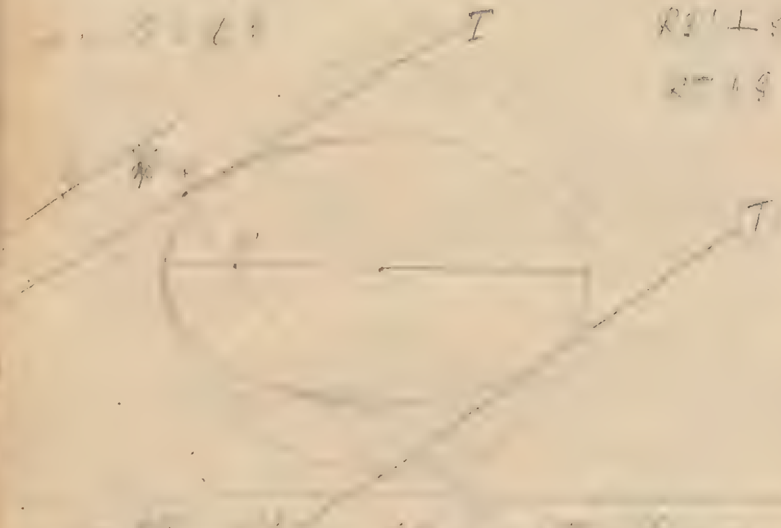


[illegible]


A
A'



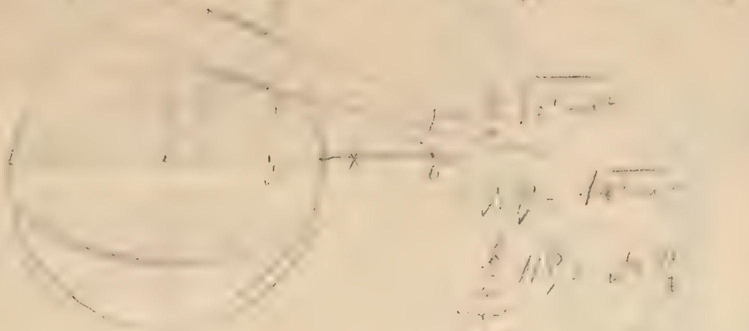
[illegible]



$RS' \perp S$

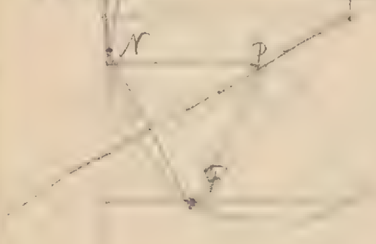
[illegible]

[illegible]



[illegible]

Fig. 1



$PP' \perp FN$

[illegible]

[illegible]

[illegible]

[illegible]

$= [illegible]$

$\cos\varphi = \frac{x + c}{r}$

[illegible]

$\cos\varphi' = \frac{x' - c}{r'}$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] $F'P$ [illegible] $F'P$

[illegible]

[illegible]


T
T'

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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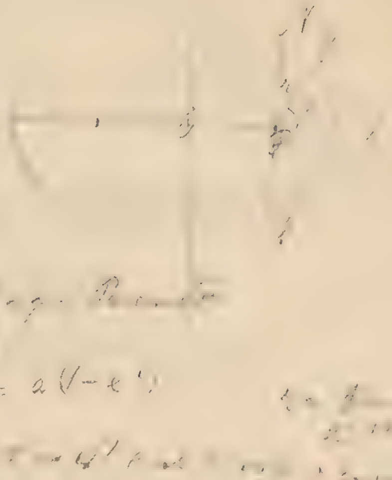
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



[illegible]

[illegible]

$\frac{p}{2} = a(1-e^2)$

[illegible]

[illegible]

[illegible]

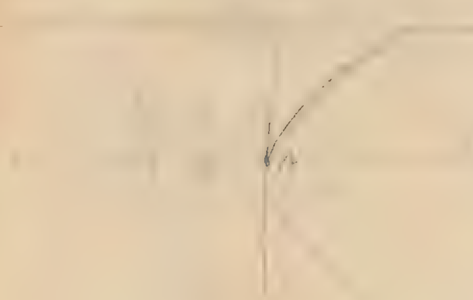
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

T [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] T

[illegible]

[illegible]

6)

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$$y = 2\sqrt{[illegible]}$$

$$p = [illegible]$$

$$p = [illegible]$$

$$p = [illegible]$$

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$y^2 = 2px$

[illegible]

$e = \frac{c}{a} = 1 -$ [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$OT = x$

[illegible]

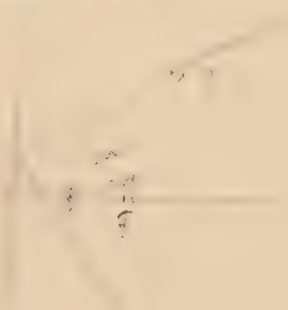
[illegible]

[illegible]

[illegible]

$z = 0$ [illegible]

[illegible]



$\cos x = -$ [illegible]

[illegible]

[illegible]

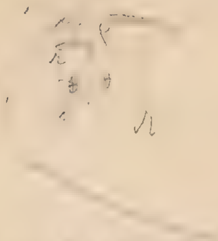
$m =$ [illegible]

[illegible]

α [illegible] T'

[illegible]

$x = -p$ [illegible]



[illegible]

[illegible]

[illegible]

[illegible]

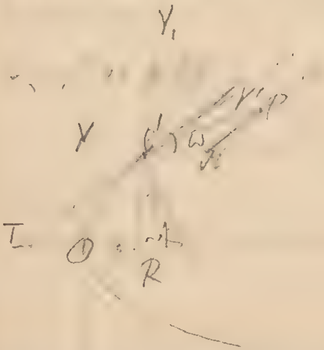
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]


Y₁
Y
X
R

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

$\xi = x + \rho\cos$ [illegible]

[illegible]

$y = -\sqrt[3]{p^2\eta}$ $x = \frac{\xi - p}{3}$

$y^2 = 2px$ $\sqrt[3]{p^4\eta^2} = 2p\left(\frac{\xi-p}{3}\right)$

[illegible]

$p^4\eta^2 = 8p^3\frac{(\xi-p)^3}{27}$

$\eta^2 = 8\frac{(\xi-p)^3}{27p}$

K_1 $K - \lambda K' = 0$

[illegible]

K_1 $K - \mu K'' = 0$

[illegible]

$K_1 - K_2$

λK [illegible] $K' - \mu K'' = 0$

$K' - \nu K'' = 0$

[illegible] I, II, III, IV,

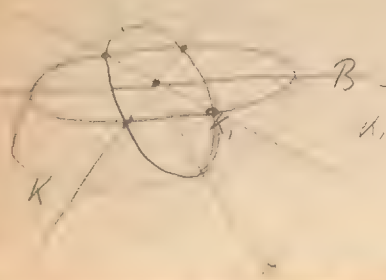
[illegible] I' II' III' IV' [illegible]

[illegible]

2 [illegible]

[illegible] Kreis

K_1 $A - \lambda B^2 = 0$



K_2 $A + \mu B^2 = 0$

$K_1 - K_2$ [illegible]

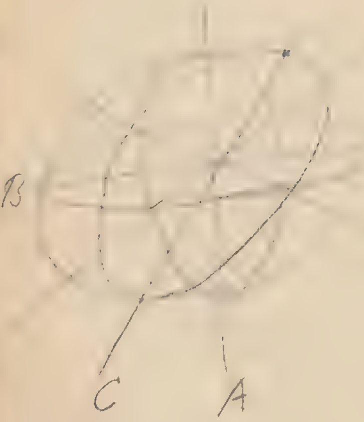
A [illegible] $= 0$

C_1 $A - C = 0$ [illegible]

$A + B = 0$

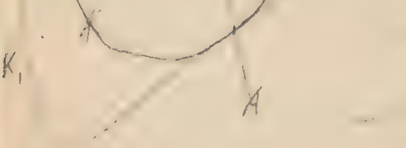
[illegible]

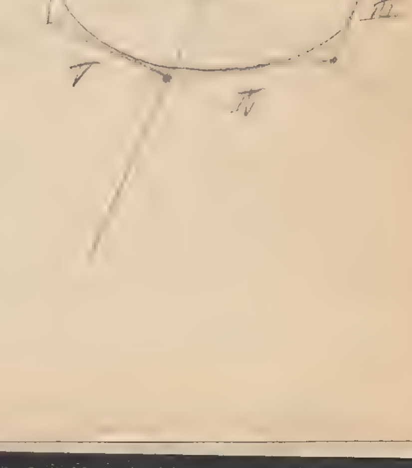
[illegible]



[illegible]

[illegible]



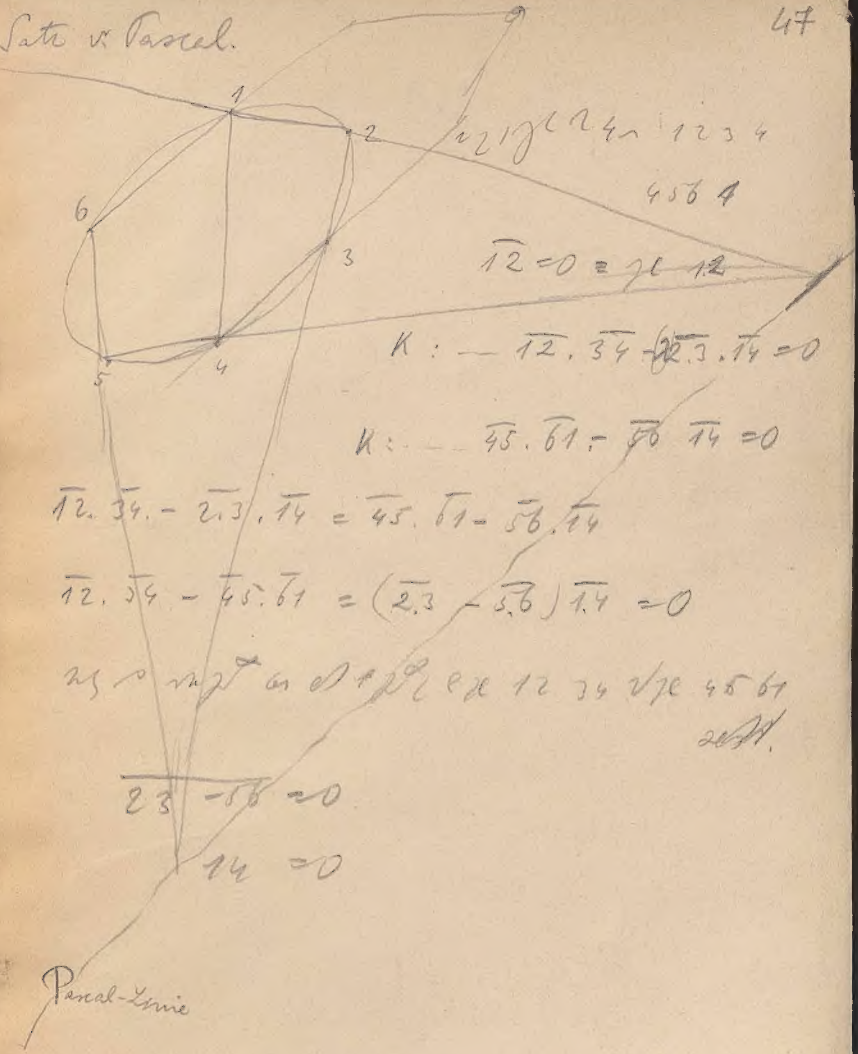


I, IV [illegible] K₁

II, V [illegible] K₂

III, VI [illegible] K₃

Satz v. Pascal.



[illegible] 1 2 3 4

4 5 6 4

$\overline{12} = 0 =$ [illegible] 12

$K : \ldots \overline{12}\,.\,\overline{34} - \overline{2.3}\,.\,\overline{14} = 0$

$K : \ldots \overline{45}\,.\,\overline{61} - \overline{56}\;\overline{14} = 0$

$\overline{12}\,.\,\overline{34}\,. - \overline{2.3}\,.\,\overline{14} = \overline{45}\,.\,\overline{61} - \overline{56}\,.\,\overline{14}$

$\overline{12}\,.\,\overline{34} - \overline{45}\,.\,\overline{61} = (\overline{2.3} - \overline{5.6})\,\overline{1.4} = 0$

[illegible] 12 34 [illegible] 45 61 [illegible].

$\overline{23} - \overline{56} = 0$

$14 = 0$